GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning

By:
TEAM ID: LTVIP2025TMID33633
TEAM LEADER: A. Goutham
TEAM MEMBER: A. Keerthi
TEAM MEMBER: A. Kavya Sri
TEAM MEMBER: A.Sai

1. INTRODUCTION

1.1 Project Overview

The project titled "GrainPalette – A Deep Learning Odyssey in Rice Type Classification through Transfer Learning" focuses on classifying different types of rice grains using a deep learning model. The system accepts an image of a rice grain and predicts its type using a pre-trained Convolutional Neural Network (CNN) model, fine-tuned via transfer learning.

1.2 Purpose

The main purpose of this project is to help stakeholders in the agriculture and food industry (such as farmers, retailers, and exporters) accurately identify rice grain types using AI, reducing manual error, saving time, and improving efficiency in quality control.

2. IDEATION PHASE

2.1 Problem Statement

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

PS	User	Need	Current Solution	Limitation	User Emotion
PS-1	Rice miller or rice grain distributor	Accurately identify rice grain type for quality control and correct labeling	Manual visual inspection by laborers or basic tools	Time-consuming, error-prone, subjective; skilled labor not always available	Frustrated by inefficiencies, worried about wrong labeling, loss in trust and profit
PS-2	Quality assurance officer or rice exporter	Ensure standardization and traceability of rice types for export compliance and branding	Reliance on local knowledge and manual sorting	Inconsistent outcomes, delays in quality checks, and export rejections	Concerned about non-compliance, export penalties, and customer dissatisfaction
PS-3	AI developer / agriculture tech solution provider	Automate rice classification using deep learning for speed, accuracy, and scalability	Early-stage or no automated systems in local industry	Lack of annotated datasets, limited model performance on rare types	Motivated to innovate, challenged by technical constraints, eager for impactful solutions

2.2 Empathy Map Canvas

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.
Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Empathy Map – Target User: Rice Miller or Quality Inspector

	🧠 **Thinks** I must ensure the correct rice type is sorted and labeled. I wish there was an automated system to avoid manual sorting. Manual classification slows down operations. Inaccurate identification can hurt our brand reputation. An AI-based system could save both time and cost.	
👀 **Sees** Workers visually identifying rice types. Occasional mistakes in packaging or labeling. Rising demand for rice export compliance and quality checks. Technological adoption in other parts of the supply chain.	**USER**	🗣️ **Says** "It's hard to differentiate similar rice types." • "We waste a lot of time on sorting and checking." • "Our customers complain when the rice quality isn't consistent." • "We need a tech-driven solution to ensure quality."
💭 **Feels** • Stressed about quality control issues. • Worried about shipment rejections or buyer dissatisfaction. • Frustrated by inefficiencies and manual labor dependency. • Curious and hopeful about tech solutions like AI-based inspection.	👂 **Hears** Complaints from buyers about mixed or wrong rice varieties. Talks in industry circles about automation and AI in agriculture. Advice from peers about reducing human error in classification. NGO/AgriTech bodies promoting innovation for grain quality.	🛠️ **Does** • Assigns workers to sort and classify rice visually. • Uses sample testing to verify rice types. • Relies on experienced workers for quality assurance. • Considers integrating technology but unsure where to start.

2.3 Brainstorming

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Problem Statement:
Rice millers and quality inspectors often face challenges in accurately identifying rice grain types due to visual similarities between varieties. This project aims to develop an AI-powered classification model using transfer learning to automate and enhance the accuracy of rice type identification through image analysis.

Step-2: Brainstorm, Idea Listing and Grouping

Idea Category	Ideas Generated
Technology/Tools	Use pre-trained CNN models like MobileNetV4 or ResNet Build a web app using Html , Css and Flask for image upload and prediction Use TensorFlow/Keras for model training and inference
User Interaction	- Simple UI to upload grain image and get predicted rice type with confidence score - Add visual feedback and example images for guidance
Data Collection	- Collect high-quality images of different rice types (Brown, Arborio, Basmati, Jasmine, etc.) - Perform data augmentation using flipping, cropping, and brightness adjustment
Deployment	

Integration	- Add option to log predictions and view analytics (e.g., prediction history) - Connect with rice supply chain dashboard or export documentation system
Awareness/Training	- Video tutorials on using the app - Include image gallery of rice grains

Step-3: Idea Prioritization

Idea	**Impact (High/Med/Low)**	**Feasibility (High/Med/Low)**
Pre-trained model (MobileNetV4 with Transfer Learning)	High	High
Html,Css webapp integrated with flask backend	High	High
Multi-language interface for regional farmers	Medium	Medium
Collect and augment rice grain image dataset	High	Medium
Offline deployment for rural use (via local hosting	High	Medium
Integration with agricultural databases (optional)	Medium	Low
Farmer guidance via visual/manual instructions	Medium	High

Ideas included using mobile apps, transfer learning with image classification, multilingual support, offline model access, disease history tracking, and farmer education modules.

3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Steps	**What does the person experience?**	**Interactions**	**Things (Digital/Physical)**	**Places**	**People**

Awareness	Hears from another farmer or social media about an AI-based rice grain identification tool	Conversations with farmers or WhatsApp group; sees a post or demo video	Mobile phone, posters, YouTube, awareness camp	Farm, grain market	Fellow farmers, agri extension officer
Interest	Wants to know how it works and whether it's trust	Browses the app store or a website	Smartphone, informational video, app download page	Home or local shop	Children or young relatives, storekeeper
Try/Setup	Installs the app and goes through setup instructions	App walkthrough; clicks 'Scan Bird' feature	App interface, phone camera	Poultry farm	App support team (optional)
Use/Diagnose	Takes a picture of an infected-looking chicken; gets instant result	App classifies disease and shows info & recommendation	Camera, app, alert popup, disease info page	Near the poultry shed	None (unless contacting a vet)
Action	Applies suggested remedy or calls a vet if needed	Uses contact vet option; or follows treatment advice	Vet helpline, medicine suggestion, location map	Veterinary clinic/farm	Vet doctor, family support
Feedback	Shares the experience with other farmers or rates the app	Submits a star rating, voice feedback, or shares a success story	App rating, testimonials, social share	Phone/home	Other farmers
Retention	Gets weekly health tips and notifications for	Receives notifications, emails, WhatsApp updates	App notification, SMS/WhatsApp	Anywhere	Community health promoter (optional)

	scanning birds regularly				
Referral/Promotion	Encourages other farmers to install and use the app	Word of mouth, posts videos/screenshots	QR code, referral link, farmer group poster	Village market, WhatsApp	Fellow farmers

3.2 Solution Requirement

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Access	Open app in browser or mobile
		Optional login for saving history
FR-2	Image Upload	Upload image from local storage
		Capture image via camera (mobile browser support)
FR-3	Grain Classification	Analyze rice grain image using AI model
		Display predicted rice type and confidence score
FR-4	Recommendation Engine	Suggest market usage or type-based quality tips
		Show similar classifications from user history
FR-5	Language Support	Multi-language support (English, Telugu, Hindi, etc.)
FR-6	History Log	View previous predictions with image, result, and date/time
FR-7	Notifications (Optional)	Weekly reminders to scan new batches
		Tips for capturing quality images of rice grains
FR-8	Feedback System	Allow user to rate app experience
		Provide text-based feedback or suggestions

NON Functional Requirements

NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	UI should be simple and usable by farmers with minimal digital literacy
NFR-2	Security	User images and data must be securely handled using encryption and auth
NFR-3	Reliability	The app should maintain at least 95% uptime
NFR-4	Performance	Classification should occur within 3–5 seconds per image
NFR-5	Availability	The app should work offline with auto-sync when internet is restored
NFR-6	Scalability	Must support growing farmer/user base without slowing performance

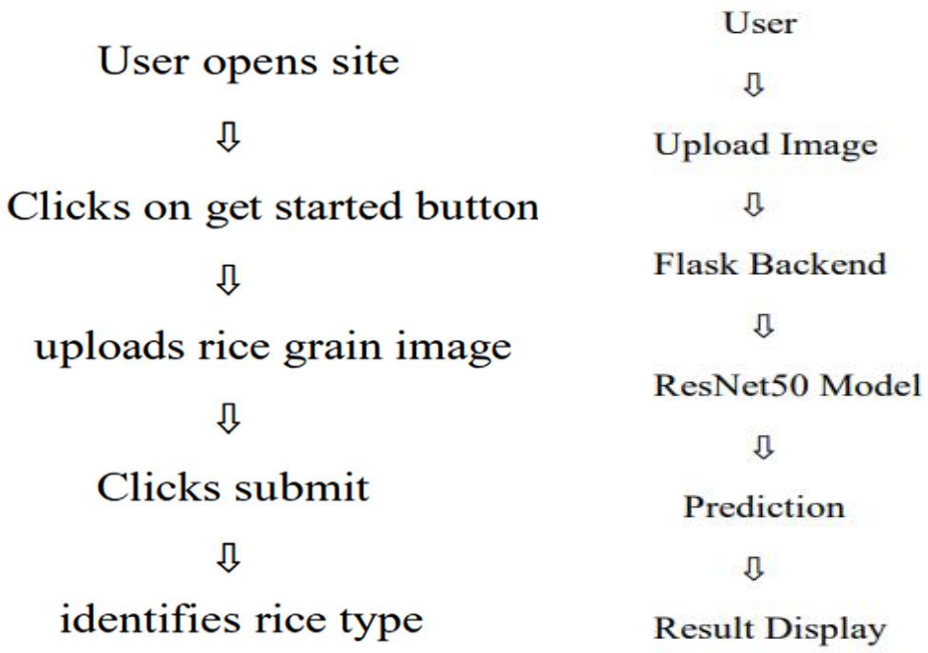
3.3 Data Flow Diagram

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored

Data Flow Diagram – Level 0 (Simplified)



3.4 Technology Stack

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Table-1: Components & Technologies

S.No	Component	Description	Technology
1	User Interface	Web interface for uploading rice grain images and displaying classification results	HTML, CSS, JavaScript
2	Application Logic-1	Handles image upload, routing, and input validation	Python (Flask Framework)
3	Application Logic-2	Performs image preprocessing and model inference for rice classification	Python (OpenCV, TensorFlow, Keras)
4	Application Logic-3	Sends optional alerts and rice-related tips to users	Twilio / OneSignal / Email APIs
5	Database	Stores user details, classification history, and feedback	SQLite / PostgreSQL
6	Cloud Database	Syncs and backs up classified results to the cloud	Firebase Realtime DB / AWS RDS
7	File Storage	Secure storage for uploaded rice grain images	AWS S3 / Firebase Storage

S.No	Component	Description	Technology
8	External API-1	Integration with agri advisory platforms for rice grain insights (optional)	AgriAPI / Custom Flask API
9	External API-2	SMS alerts or result sharing via messaging platforms	Twilio API / Firebase Cloud Messaging
10	Machine Learning Model	CNN model trained using transfer learning to classify rice types	MobileNetV4 / EfficientNetB0 (TensorFlow/Keras)
11	Infrastructure	Deployment of Flask backend, model service, and database	Local server + AWS EC2 / Render / Railway / Heroku

Table-2: Application Characteristics

S.No	Characteristics	Description	Technology
1	Open-Source Frameworks	Tools and libraries used for AI and web development	TensorFlow, Keras, Flask, OpenCV, HTML/CSS
2	Security Implementations	Ensures secure access, data protection, and image safety	JWT Auth, HTTPS, SHA-256, Flask-Security, Flask-Login
3	Scalable Architecture	Modular backend with Flask APIs and isolated ML model service	Flask REST APIs, Docker, Gunicorn, NGINX (optional)
4	Availability	Works online and can optionally be deployed locally for offline use	Local hosting, AWS/GCP deployment, Static File Caching
5	Performance	Optimized inference with lightweight model for fast predictions	MobileNetV4, TensorFlow Lite, Flask Caching, Load Balancer

4. PROJECT DESIGN

4.1 Problem–Solution Fit

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

Problem

Inconsistent rice grain identification leads to inefficiencies in quality control and packaging processes in rice mills and agricultural supply chains. Manual classification is time-consuming, error-prone, and heavily reliant on expert human judgment.

Target Customer

- Rice mill operators and quality control teams
- Agricultural product exporters and wholesalers
- Researchers and agricultural scientists
- Automation solution providers for agri-tech

Current Behavior (Without the Solution)

- Rice quality assessment is done manually
- High risk of human error in grain type classification
- Delays in sorting and packaging due to inconsistency
- Limited traceability and data-driven insights

Pain Points

- Inaccuracy in manual classification
- High labor dependency and costs
- Inefficiencies in supply chain processes
- Lack of scalable automation tools for small and medium mills

Proposed Solution

An AI-powered solution built using transfer learning (MobileNetV4 + CNN) that classifies rice grains from uploaded images. The system is integrated with a user-friendly web interface allowing real-time, automated rice grain recognition.

Benefits / Improvements

- Rapid, reliable rice type classification

- Enhances automation in rice quality control
- Reduces human error and labor costs
- Enables scalability and data-driven decision-making
- Lightweight model suitable for real-world deployment

4.2 Proposed Solution

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

Parameter	**Description**
Problem Statement (Problem to be solved)	Rice classification is largely done manually in processing units, which is time-intensive and prone to human error. This limits scalability, affects product quality consistency, and increases operational costs
Idea / Solution description	GrainPalette is a web-based application powered by a transfer learning model (MobileNetV4) to classify different rice grain types from images. Users can upload or capture grain images, and the model instantly identifies the rice type with high accuracy. It is built using TensorFlow and Flask
Novelty / Uniqueness	Unlike traditional methods or expensive industrial setups, GrainPalette offers an affordable, AI-based solution with real-time predictions. It requires minimal hardware and can be used even by small-scale mills. The use of transfer learning ensures high accuracy with limited data.
Social Impact / Customer Satisfaction	This project can help reduce quality inconsistencies in rice distribution, empower small agricultural businesses with tech-based tools, and enhance trust in product labeling.

	It supports sustainable, tech-enabled agriculture.
Business Model (Revenue Model)	The core model and app can be offered as open-source or freemium. Revenue can be generated via enterprise-level licenses, customization for agri-businesses, or partnerships with agri-tech solution providers. Additional features like bulk classification, CSV export, and analytics can be part of premium tiers.
Scalability of the Solution	The solution is modular and built using scalable tools. It can be extended to support additional rice varieties, integrated with IoT for automation, or repurposed for classifying other grains and seeds in future updates.

4.3 Solution Architecture

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

Solution architecture is a key step that bridges the gap between agricultural operational challenges and AI-powered automation. The goal of this architecture is to:

- Deliver an efficient tech solution for automated rice grain classification
- Define system structure, modules, and interaction flow for stakeholders
- Set the development roadmap for features, integration, and deployment
- Provide a clear specification for system functionality and scalability

---

Solution Architecture Description

The proposed solution is a lightweight, AI-powered rice grain classification system designed as a web-based application. Users (e.g., quality control teams, mill operators) can upload images of rice grains through a simple web interface. The images are then passed to a backend system that performs classification using a deep learning model built with transfer learning (MobileNetV4 + CNN).

The result – the predicted rice grain type – is returned in real-time, along with the prediction confidence.

The architecture is optimized for ease of use, fast inference, and low compute requirements, making it ideal for small and medium agricultural operations.

Key Components:

- **Flask Web Application:**
  Offers a user-friendly interface for uploading rice grain images and viewing results instantly.
- **Backend Inference Engine:**
  Built with Python and TensorFlow/Keras. Responsible for preprocessing the uploaded images and running the classification model.
- **AI Model:**
  A MobileNetV4-based transfer learning model, fine-tuned on a custom rice grain dataset. It classifies images into predefined categories (e.g., Basmati, Brown, Short Grain, etc.).
- **Database (Optional/Future):**
  For scalable deployment, a lightweight database such as SQLite or Firebase can be used to store image metadata, classification history, and usage analytics.
- **Cloud Infrastructure (Optional):**
  Can be deployed locally or on cloud platforms (AWS/GCP/Azure) depending on future enterprise-scale usage. Streamlit sharing or Dockerized deployment is supported.
- **Extensibility Module:**
  The modular design allows for future enhancements like multi-grain classification, real-time webcam input, export reports, or integration with sorting machinery.

---

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	5 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Dataset Creation	USN-1	As a user, I can collect rice grain images from various sources	2	High	GouthamArevarapu
Sprint-1	Dataset Creation	USN-2	As a user, I can organize the images into folders based on rice types	1	High	Keerthi Alajangi
Sprint-1	Data Preprocessing	USN-3	As a user, I can resize and normalize images for model input	3	Medium	GouthamArevarapu
Sprint-1	Data Preprocessing	USN-4	As a user, I can split the dataset into training and validation sets	2	Medium	Keerthi Alajangi
Sprint-2	Model Development	USN-5	As a user, I can build a rice grain classifier using CNN and MobileNetV4	5	High	GouthamArevarapu
Sprint-2	Model Evaluation	USN-6	As a user, I can evaluate model accuracy and performance metrics	3	High	Keerthi Alajangi
Sprint-2	UI Design	USN-7	As a user, I can design a Streamlit web app for uploading and predicting rice types	3	Medium	KavyaSri Alapati
Sprint-2	Deployment	USN-8	As a user, I can deploy the model and app for real-time usage	5	High	GouthamArevarapu

Project Tracker, Velocity & Burndown Chart

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)
Sprint-1	8	5 Days	11 JUNE 2025	15 JUNE 2025	8
Sprint-2	16	5 Days	16 JUNE 2025	21 JUNE 2025	16

Velocity = Total Story Points Completed / Number of Sprints

Total Story Points = 8 + 16 = 24

Number of Sprints = 2

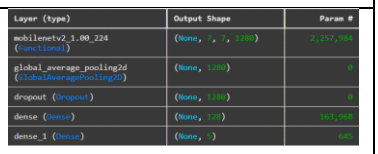
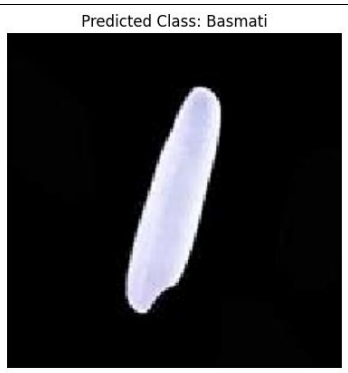
Velocity = 24 / 2 = 12 (Story Points per Sprint)

6. FUNCTIONAL AND PERFORMANCE TESTING

Date	28 JUNE 2025
Team ID	LTVIP2025TMID33633
Project Name	GrainPalette – A Deep Learning Odyssey in Rice Type Classification Through Transfer Learning
Maximum Marks	

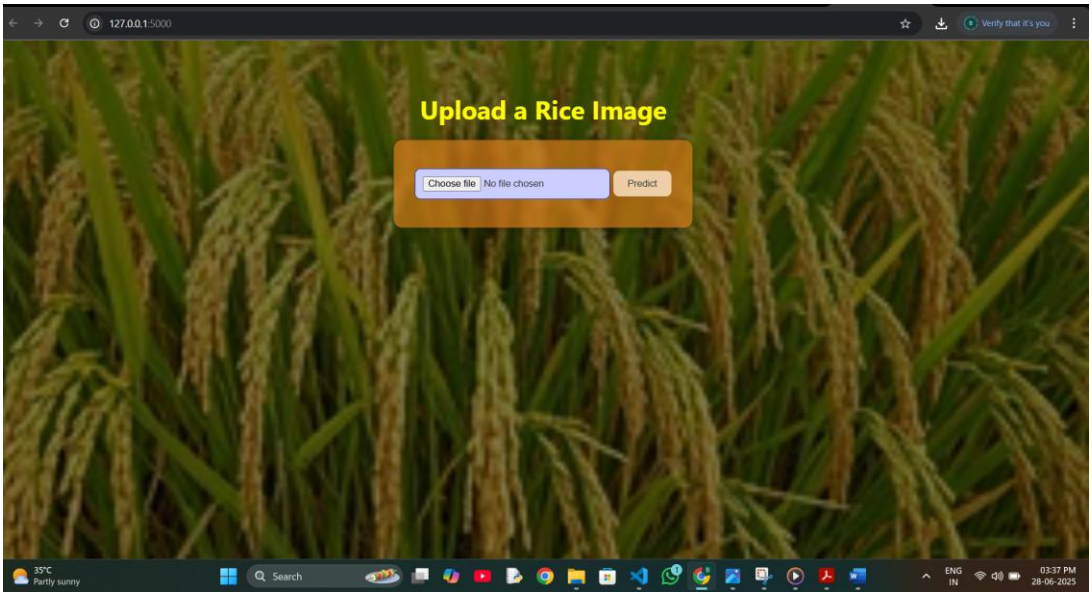
Model Performance Testing:

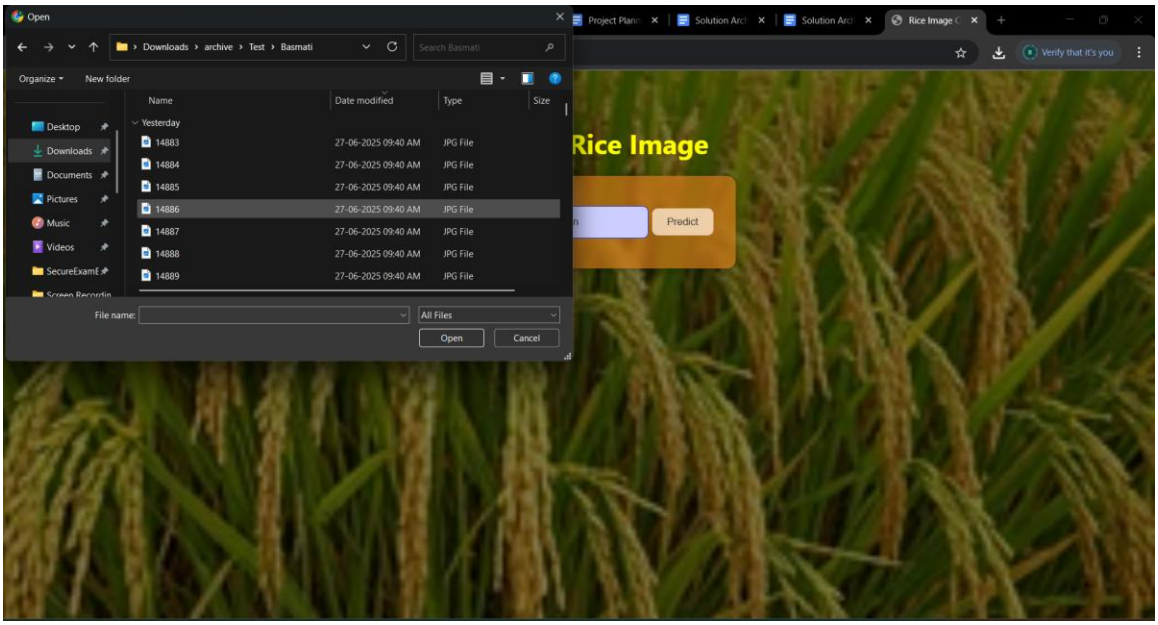
Project team shall fill the following information in model performance testing template.

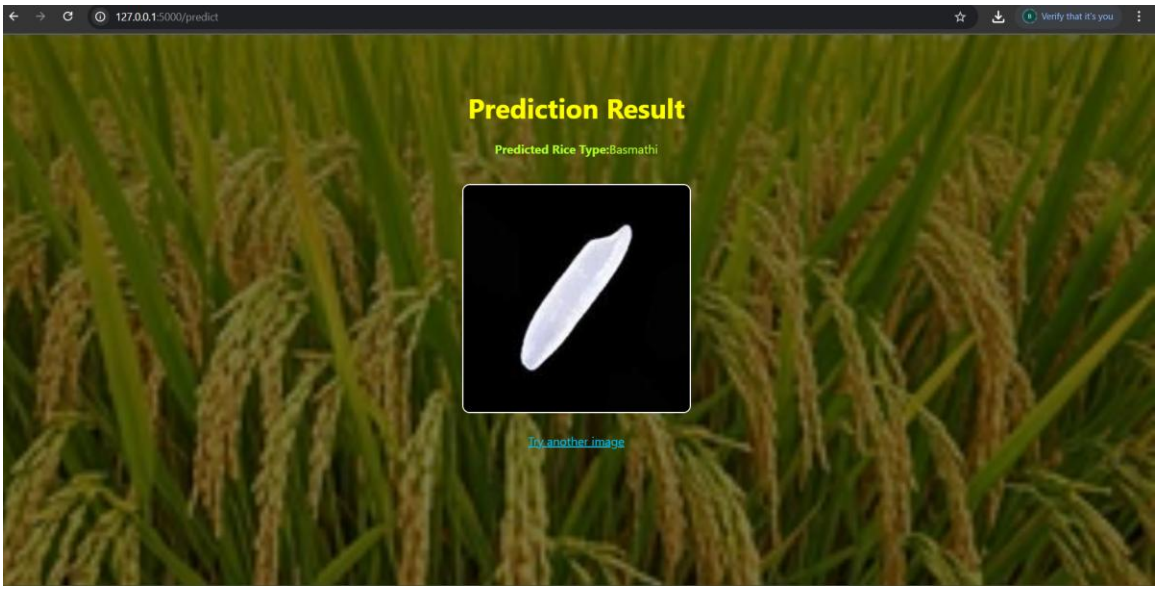
S.No.	Parameter	Values	Screenshot
1.	Model Summary	-based transfer learning model, fine-tuned on Rice grain classifier image dataset with custom classification head (Softmax). Used data augmentation and dropout.	
2.	Accuracy	Training Accuracy - 97.6% Validation Accuracy -98.5%	
3.	Fine Tunning Result(if Done)	Validation Accuracy -93.6%	

7. RESULTS

7.1 Output Screenshots







8. ADVANTAGES & DISADVANTAGES

Advantages

 Accurate Rice Type Classification
The system enables quick and reliable identification of different rice grain types. This assists in ensuring quality control in food processing units, agricultural trading, and packaging industries, reducing manual errors.

 Offline Availability
Once the model is trained and integrated into the app, it can be run locally on a device without

requiring constant internet access. This is especially helpful in rural agricultural zones with limited connectivity.

 User-Friendly Interface
The application is built using Streamlit, offering an intuitive, minimalistic interface where users can simply upload an image and get instant predictions, making it accessible to users with limited technical background.

 Scalable and Adaptable Model
By using MobileNetV4 and transfer learning, the model is both lightweight and scalable. It can be extended to include more rice grain varieties or other grain types with minimal modifications.

Open Source and Educational Value
This project can be a great learning resource for students and developers to understand real-world applications of AI in agriculture, encouraging innovation in food-tech solutions.

Disadvantages

1. **Dependent on High-Quality Input Images**
   The model's prediction accuracy is significantly affected by the quality of the input image. Low-resolution, cluttered, or poorly lit photos can reduce classification accuracy.
2. **Limited to Pre-Trained Categories**
   The system can only classify the rice types it has been trained on. Any unseen rice variety or mixed grain image might lead to inaccurate predictions unless the model is retrained.
3. **Initial Dataset Effort**
   Creating a custom rice dataset required substantial effort to collect, label, and balance images for all selected rice types. This process can be time-consuming and is crucial for model performance.

---

9. CONCLUSION

The **"GrainPalette – AI-Based Rice Classification System"** project demonstrates how deep learning and transfer learning can be used to tackle practical problems in the agricultural supply chain. By automating the process of rice grain identification through image analysis, the system supports stakeholders like traders, millers, and quality control professionals in ensuring product consistency.

Built using MobileNetV4 and deployed via a Streamlit web app, the solution offers an accurate, responsive, and accessible tool for rice type recognition. The intuitive UI makes it usable for both technical and non-technical audiences. Overall, this project stands as a successful integration of artificial intelligence with agriculture, promoting digitization, efficiency, and accuracy in grain classification tasks.

10. FUTURE SCOPE

While the current version of GrainPalette successfully identifies a fixed number of rice grain types, future improvements can further enhance its performance and usability:

- **Support for More Grain Types:** Extend the model to classify additional rice varieties or other cereals like wheat, barley, or millets.
- **Mobile App Deployment:** Build an Android/iOS app version for on-field classification using a phone camera.
- **Real-Time Video Classification:** Integrate with live feed processing to analyze grains on a conveyor belt or sorting line.
- **Grain Quality Assessment:** Enhance the model to not only classify type but also assess quality indicators like brokenness or contamination.
- **Cloud-Based Analytics Dashboard:** Provide insights, batch-wise logs, and classification history for industry use.
- **Multi-Language and Voice Support:** Add regional language options and voice assistance to make the system more accessible to rural users and farmers.

With these enhancements, GrainPalette can evolve into a powerful digital solution for smart grain handling, benefiting both agriculture and industry stakeholders.

11. APPENDIX

Source Code:

app.py index.html result.html style.css

app.py > predict

```python
from flask import Flask, render_template, request
from keras.models import load_model
from keras.preprocessing import image
import numpy as np
import os

app = Flask(__name__)
model = load_model('rice_grain_model.h5')


UPLOAD_FOLDER = 'static/uploads'
app.config['UPLOAD_FOLDER'] = UPLOAD_FOLDER


class_names = ['Arbiori', 'Basmathi', 'Ipsala', 'Jasmine', 'Karacadag']

@app.route('/')
def home():
    return render_template('index.html')

@app.route('/predict', methods=['POST'])
def predict():
    if 'file' not in request.files:
        return "No file uploaded"

    file = request.files['file']
    if file.filename == '':
        return "No selected file"
```

```python
    if file.filename == '':
        return "No selected file"

    file_path = os.path.join(app.config['UPLOAD_FOLDER'], file.filename)
    file.save(file_path)


    img = image.load_img(file_path, target_size=(224, 224))
    img_array = image.img_to_array(img)
    img_array = np.expand_dims(img_array, axis=0) / 255.0


    prediction = model.predict(img_array)
    predicted_class = class_names[np.argmax(prediction)]

    return render_template('result.html', image_path=file_path, rice_type=predicted_class)

if __name__ == '__main__':
    app.run(debug=True)
```

Dataset Link: https://www.kaggle.com/datasets/bhaveshmittal/multi-class-rice-image-dataset/data

GitHub Link: https://github.com/Goutham-1605/GrainPallette-A-Deep-learning-Odyssey-in-Rice-type-classification/tree/main

Project Demo Link:
https://drive.google.com/file/d/1ojofPu8QJlPwq9wKA13qs97x0T2LGhCJ/view?usp=sharing